



JUNE 28 - 30, 2005 NORFOLK CONVENTION CENTER

## **Critical Issues in Migrating to Network-Centric Operations**

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June 30, 2005



## FORCEnet Operational View



- Sea Power 21 – “Naval”
- Joint from Inception
  - GIG-BE
  - TCA
  - NCES
  - JTR
  - Others
- Commercial Standards
- Spiral Development with Sea Trial
- Warrior Focused

Slides from SPAWAR briefing “FORCEnet – Engineering & Architecting The Navy’s IT Future” presented at the NMCI Industry Symposium, June 19, 2003



## FORCEnet Operational

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**FORCEnet will depend upon a distributed web-based computing environment to support gridded sensors, shooters, and decision-makers.**

*A number of critical organizational and technology issues for interoperability need to be addressed to implement its vision.*

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Slides from SPAWAR briefing “FORCEnet – Engineering & Architecting The Navy’s IT Future”  
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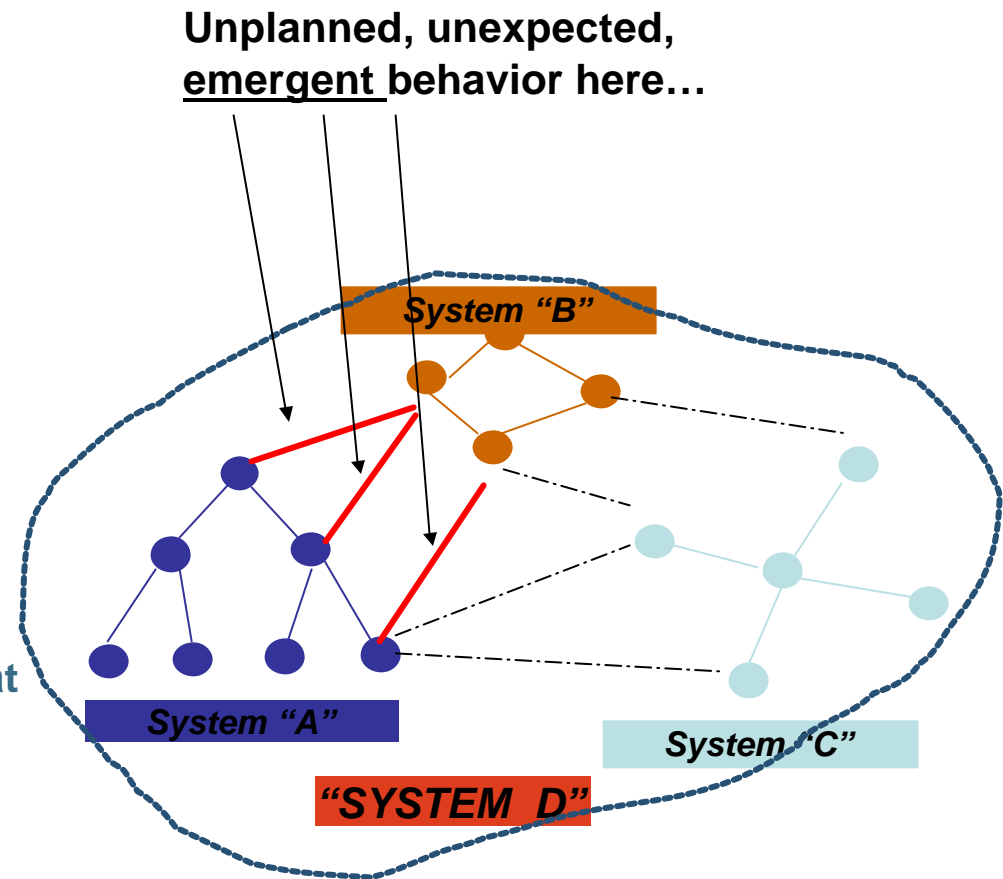
- **Most modern systems are usually a heterogeneous collection of custom and commercial products**
  - **Integration provided by some third-party technology**
- **Modern systems are seldom expected to function independently**
  - **Expected to cooperate with existing systems**
  - **The ability to achieve “cooperation” is generally termed “interoperability”**
- **Elements of these cooperating systems undergo frequent change (e.g., upgrades of commercial products)**
- **Thus: boundaries within and between systems begin to blur**
  - **Distinction between a "system of systems" and a single, complex, distributed system disappears**



We know quite a lot about constructing systems from components (over which we may have little or no control).

We know something about composing *systems of systems* from individual systems (over which we may have little or no control).

We know very little about constructing an *interoperable network of systems*...the key distinction being that the network is **unbounded** (or very loosely bounded) and has no single controlling authority.





# The Problem Space



- **Incomplete understanding of scope and nature of the engineering to be accomplished**
  - **Cannot discern incompatible solutions or intractable problems**
- **Ongoing inertia toward separate programs, managed and executed independently**
  - **Cannot, in such a climate, ensure that independent programs act in service of a common goal (i.e., the interoperable end goal)**
- **Supporting technologies to support required large scale interoperability are only beginning to emerge**



## Some General Principles



- “Interoperability” is a multi-dimensional aspect of system engineering.
  - Scope is far greater than simply interoperability of data
  - Scope includes degrees of coupling, ownership ...
  - Scope includes interoperability at the organizational and management levels
- We can never anticipate fully the boundaries within which a given system will be expected to operate.
  - There will always be new things to integrate into the system.
  - Integrating systems in a network can affect all other systems in the network in unintended ways.



- Size matters:
  - As integration in the small gets larger, new problems creep in: management, organizational.
  - As systems get more complex, interoperability issues increase.
- No one-time solution is possible
  - Constant upgrades and changes to constituent systems will impact the entire systems of systems configuration.
- Interoperability must be quantifiable to be achievable.
- Interoperability must be sustainable and sustained.





- Conceptual challenges
  - Characteristics
  - Models
  - Dependencies
- Technology challenges
  - Web services
  - Grid
  - Scalability, performance, emergent properties
- Practical challenges for companies and organizations
  - Organizational risks
  - Decisions on technology
  - Decisions on migration



# Interoperability Issues Analysis



- Focus on organizations and systems that are critical to success for achieving interoperability
- Identify risks, interoperability lessons, and useful practices
- Identification of primary interoperability issues and risks that can “bite” an organization
- Outline of an approach for addressing the issues
- Development of action items for follow-up



# Common Patterns of Interoperability Problems- 1



- Need for understanding on scope and mechanisms of interoperability
- Divisions of responsibility
  - Many divisions in responsibility, obligation, and management
  - Potential results of these divisions:
    - Things will fall through cracks
    - When problems occur, finger pointing can occur
- Requirements
  - Requirements for interoperability are often ill-defined except to “work together”
  - Requirements for different components and systems often continue to evolve
- Functionality
  - Not all capabilities of different versions are compatible
  - Achieving backward compatibility represents a major challenge



## Common Patterns of Interoperability Problems- 2



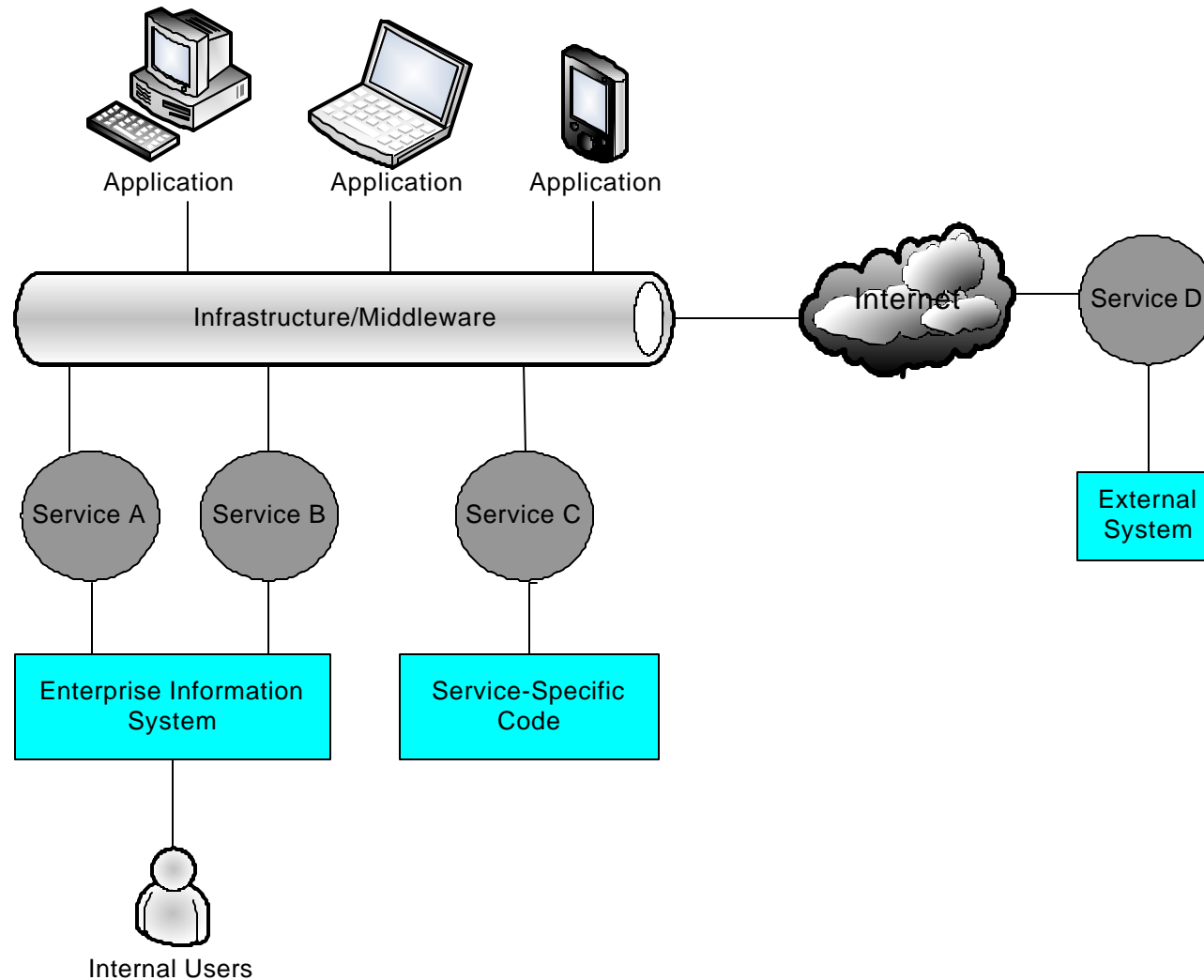
- Processes (development and integration)
  - There is often some degree of misfit between processes, methods and tools employed by different contributors to the system
- Other potential showstopper issues
  - Scalability
  - Performance
  - Security
  - Testing



- SMART: Service Migration Analysis for Reuse  
Technique Analyze legacy components to determine potential for reuse as services with a specific SOA target
- Approach:
  - Perform initial analysis of reuse potential
  - Perform an architecture reconstruction to determine dependencies of as-built system
  - Inspect code for general quality issues
  - Review target SOA environment
  - Determine the feasibility of task



# Background—SOA

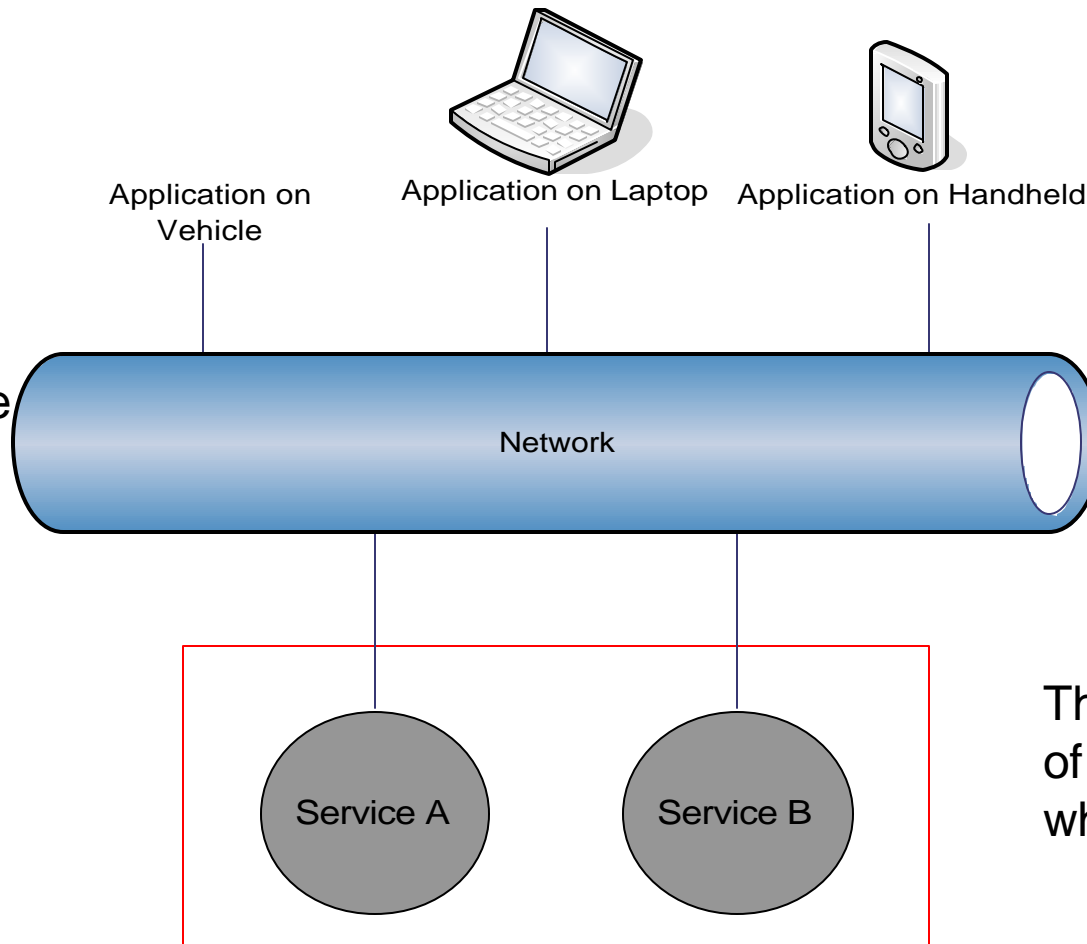




Services are discovered and used as part of external applications.

Details of the network and its users are transparent to the service.

Current functionality is migrated as services.



Applications are written by third parties who have specific requirements.

This is the only portion of the system over which you have control



## Global Issues to Address in Moving to Services



- Gather requirements from potential service users
  - Who would use the services and how would they use them?
- Understand the target environment
  - Bindings, messaging technologies, communication protocols, service description languages, and discovery services.
- Analyze the effort involved in writing the code that receives the request, translates it into calls into the legacy systems, and produces a response.

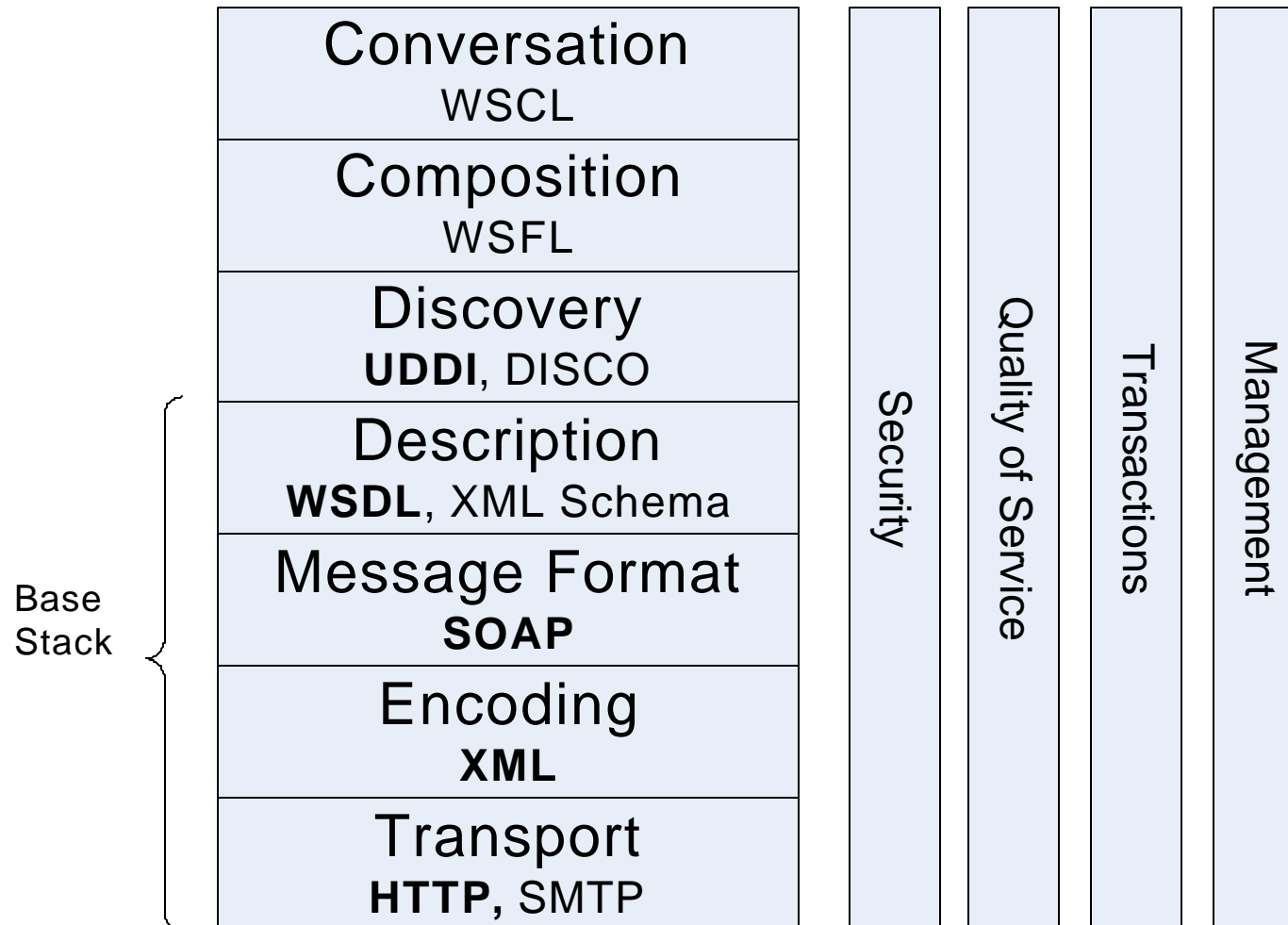




1. Define model problems
2. Investigate technologies
  - Model Driven Architecture (MDA)
  - Integrated Development Environments (IDEs) for J2EE and .NET
  - Service Oriented Architectures
  - Globus toolkit
3. Develop collaborations with research community
4. Determine realistic expectations for acquisition and development community



# Technologies Required for Web Services



Adapted from "XML and Web Services Unleashed", SAMS Publishing



## Hypothesis Example

There is a large number of public, easily-locatable, and high-quality Web Services that can be used in applications



- Initially planned on using a public travel Web service to find travel arrangements
- Could not find any real, decent Web service
  - Public UDDI repositories contained test Web services that did not work
  - No commercial airlines or travel agencies had Web Services for this
- Had to settle for finding closest airport to the location of the new assignment using three public Web services
  - Latitude/longitude of a given city
  - Airports in a given country (including latitude/longitude)
  - Distance calculation given two latitude/longitude coordinates
- Hypothesis refuted
- Work in progress



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## Hypothesis Example: Preliminary Findings

There is a large number of public, easily-locatable, and high-quality Web Services that can be used in applications



- Loaded city/country data in the database from a country/capital web page
- Noticed that country/capital data was in country's native language and often contained special characters
- Location web services use countries and cities in English
- Had to load data from a different web site
- How do you specify these things in a Web Service?



- Enable organizations to successfully achieve system of systems interoperability.
  - Develop Interoperability Analysis Instruments
  - Develop guidance on technologies and methods for interoperability
  - Research fundamental principles in achieving net centric operations
    - Articulate software implications of net centric operations
    - Investigate costs/risks of interoperability
    - Investigate organizational and management issues in achieving net centric operations